PUERTO RICO AND VIRGIN ISLANDS PRECIPITATION FREQUENCY PROJECT

Update of *Technical Paper No. 42* and *Technical Paper No. 53*

Eighteenth Progress Report
1 October 2004 through 31 December 2004

Hydrometeorological Design Studies Center
Hydrology Laboratory

Office of Hydrologic Development
U.S. National Weather Service
National Oceanic and Atmospheric Administration
Silver Spring, Maryland

January 2005

DISCLAIMER

The data and information presented in this report are provided only to demonstrate current progress on the various technical tasks associated with this project. Values presented herein are NOT intended for any other use beyond the scope of this progress report. Anyone using any data or information presented in this report for any purpose other than for what it was intended does so at their own risk

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1. Introduction

The Hydrometeorological Design Studies Center (HDSC), Hydrology Laboratory, Office of Hydrologic Development, U.S. National Weather Service is updating its precipitation frequency estimates for Puerto Rico and the Virgin Islands. Current precipitation frequency estimates for the area are contained in *Technical Paper No. 42* "Generalized estimates of probable maximum precipitation and rainfall-frequency data for Puerto Rico and Virgin Islands" (U.S. Weather Bureau, 1961) and *Technical Paper No. 53* "Two- to ten-day rainfall for return periods of 2 to 100 years in Puerto Rico and Virgin Islands" (Miller, 1965). The new project includes collecting data and performing quality control, compiling and formatting datasets for analyses, selecting applicable frequency distributions and fitting techniques, analyzing data, mapping and preparing reports and other documentation.

The project will determine annual precipitation frequencies for durations from 5 minutes to 60 days, for return periods from 2 to 1,000 years. The project will review and process all available rainfall data for the Puerto Rico and Virgin Island project area and use accepted statistical methods. The project results will be published as a Volume of NOAA Atlas 14 on the internet using web pages with the additional ability to download digital files.

The project area covers Puerto Rico and the U.S. Virgin Islands of St. Thomas, St. John and St. Croix. The project area is currently divided into 7 homogeneous climatic regions for analysis (Figure 1).

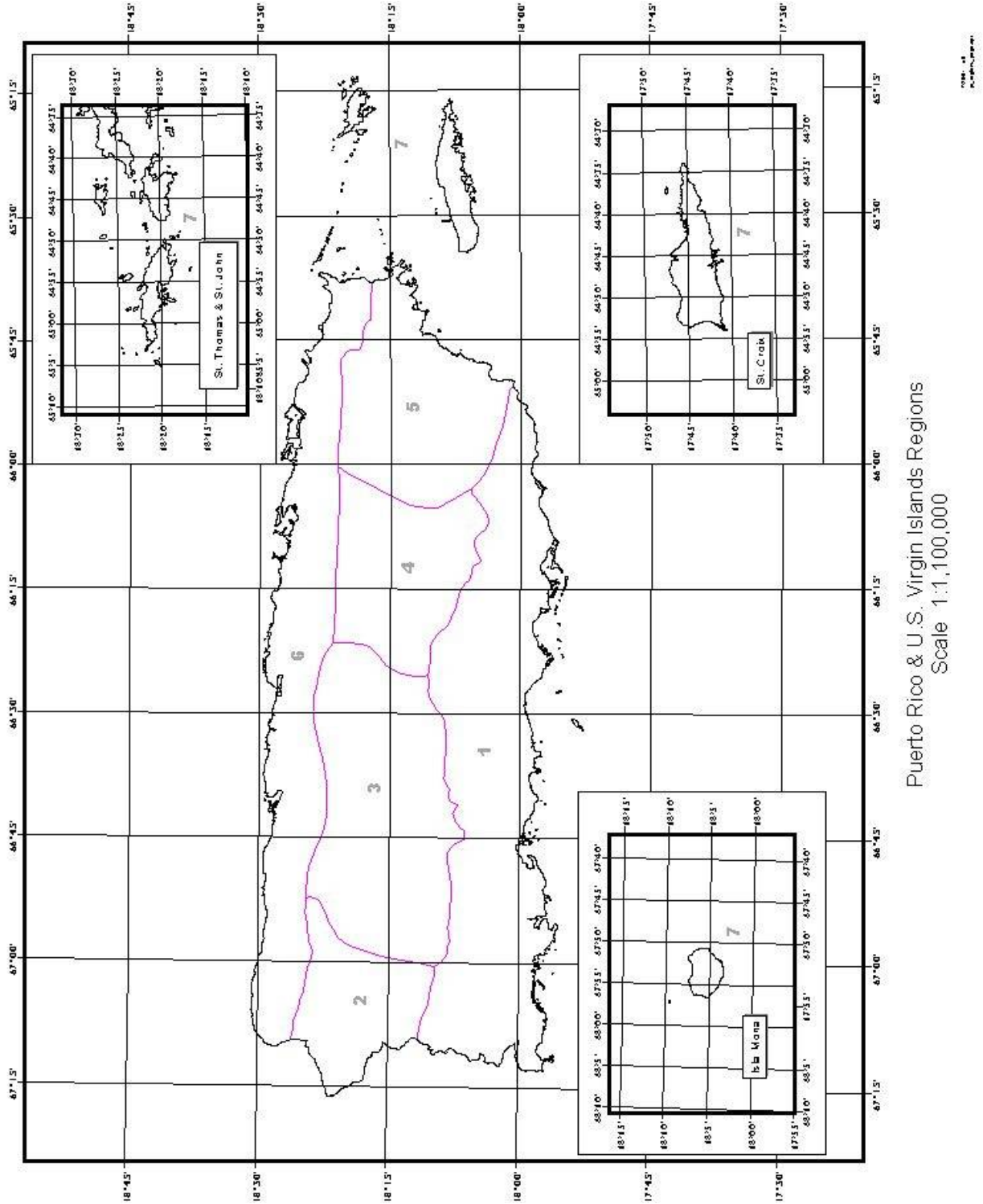


Figure 1. Puerto Rico Precipitation Frequency project area and region boundaries.

2. Highlights

Quality control of the National Climatic Data Center (NCDC) 15-minute dataset is complete. Work continues on the United States Geological Survey (USGS) 15-minute dataset. The merging of appropriate daily and hourly stations is complete. Station location issues were also addressed. Additional information is provided in Section 3.1, Data Collection and Quality Control.

Additional software has been written to improve the data quality control process. First, software to screen 15-minute data for common recurring errors was written. Second, software to screen all maximum values in the time series of all durations is being developed. Additional information is provided in Section 3.2, Software Updates.

The Precipitation Frequency Data Server (PFDS) - the on-line portal for all NOAA Atlas 14 deliverables and information - under went several subtle, but important changes. The computer server for the PFDS was replaced with a much faster computer which reduces waiting time when downloading results. Additional information is provided in Section 3.3, PFDS.

Progress continues in the development of geographically-fixed Areal Reduction Factor (ARF) curves for basin area sizes of 10 to 400 square miles. Development and testing of software is 95% complete. There are currently 14 study areas located throughout the conterminous U.S., Hawaii, and Puerto Rico that have been quality controlled, processed and ready for ARF analysis. Additional information is provided in Section 3.4, Areal Reduction Factors.

3. Progress in this Reporting Period

3.1 Data Collection and Quality Control

The quality control of 15-minute observations above a threshold of 0.50 inches is complete for the National Climatic Data Center (NCDC) dataset and is in progress for the United States Geological Survey (USGS) dataset.

In addition to the threshold check, the USGS 15-minute data are being closely scrutinized to investigate possible recurring errors. Software was written to capture recurring errors where the gauge appeared to malfunction and recorded a series of high values (see Section 3.2, Software Updates). The list of suspect observations identified by this software is being investigated. For additional screening, new quality control software has been run on the USGS 15-minute data accumulated to 1-hour durations (see Section 3.2, Software Updates). This software produces a list of possible erroneous values based on a comparison of annual maxima with data from nearby stations using statistical and spatial techniques. These suspect values are also being investigated. There is considerable effort being expended on the USGS 15-minute data. The spatial and temporal importance of these stations will be weighed against the effort needed for quality control to determine whether or not they will be included in the n-minute precipitation frequency analysis or in the temporal distribution analysis.

Daily and hourly stations in the project area within 1 mile in horizontal distance and 100 feet in elevation with non-concurrent records were considered for merging to increase record length and reduce spatial overlaps. The 24-hour annual maximum series of candidate stations were tested using a statistical t-test to ensure the samples were from the same population and appropriate to be merged. Eight pairs of daily stations were merged after meeting all criteria and visual inspection on a station map. No hourly stations met these criteria and so none were merged.

Possibly erroneous daily and hourly station locations were addressed by verifying the locations with those used for the PRISM mapping of mean annual precipitation by the Spatial Climate Analysis Service (SCAS) at Oregon State University. The PRISM locations were considered more accurate since they had been extensively quality controlled.

3.2 Software Updates

Additional software has been written to improve the data quality control process. First, software to identify cases where a series of possibly erroneous high values occurred in 15-minute data was developed. A series of high values may indicate where the gauge was malfunctioning. The software creates a log file of such cases to be manually investigated.

Second, a new quality control process is being developed. The goal is to provide an objective process for screening annual maximum series (AMS) and partial duration series (PDS) data to identify maximum precipitation values that are suspect. The process compares an annual maximum (or partial duration maximum) with the values at nearby stations within a given distance on the given observation day. It accounts for the possibility of differing observations times by buffering the observation day with one day before and after the event. Then a percentage of mean annual precipitation is calculated at each station by adding the observation day + buffer days and dividing by the mean annual precipitation as derived from PRISM grids. The subsequent point percentages are spatially distributed and then heavily smoothed. The difference in point percentages between the smoothed and unsmoothed grids at the target station is, in part, used to determine whether a particular maximum is suspect or not. Other indicators of values include station density, spatial variability, and the highest station precipitation reported within the radius of influence. Efforts are being made so that the difference threshold can vary in space and time depending on the terrain and expected type of precipitation. The advantage of this quality control screening process is that it not only captures cases where a maximum is too high, but it can also capture cases where an annual maximum is too low relative to nearby stations. Such stations and dates are identified for further manual quality control. This process is being tested on the 1-hour through 60-day durations of the Puerto Rico data series.

3.3 PFDS

The Precipitation Frequency Data Server (PFDS) - the on-line portal for all NOAA Atlas 14 deliverables and information - under went several subtle, but important changes. They include:

1. Added several frequently asked questions (FAQ) to the FAQ page.
2. Added this important cartographic map usage caveat to the “GIS Data and Maps” page:

   The color maps should not be used for interpolating point or areal precipitation frequency estimates. Point and areal values should be obtained from the PFDS interface which gets data directly from the high resolution grids. The color maps were created to serve as visual aids only.

3. Continued to update the PFDS Performance and Stats page on a monthly basis (see below).
4. Made several subtle changes to the NOAA Atlas 14 Download page, however plans are underway to make this page even more user-friendly in the future.
5. Reorganized state-specific pages
   a. Moved buttons to ancillary information to top of page
   b. Added NWS background to top of page
   c. Added FAQ button

On December 12, 2004, the PFDS server was replaced with a much faster computer which reduces waiting time when downloading results.

HDSC continuously monitors the hits, integrity and performance of the PFDS. The graph (Figure 2) below summarizes the number of individual data inquires made since January 2004, while the map (Figure 3) indicates the locations of inquires during the past quarter.

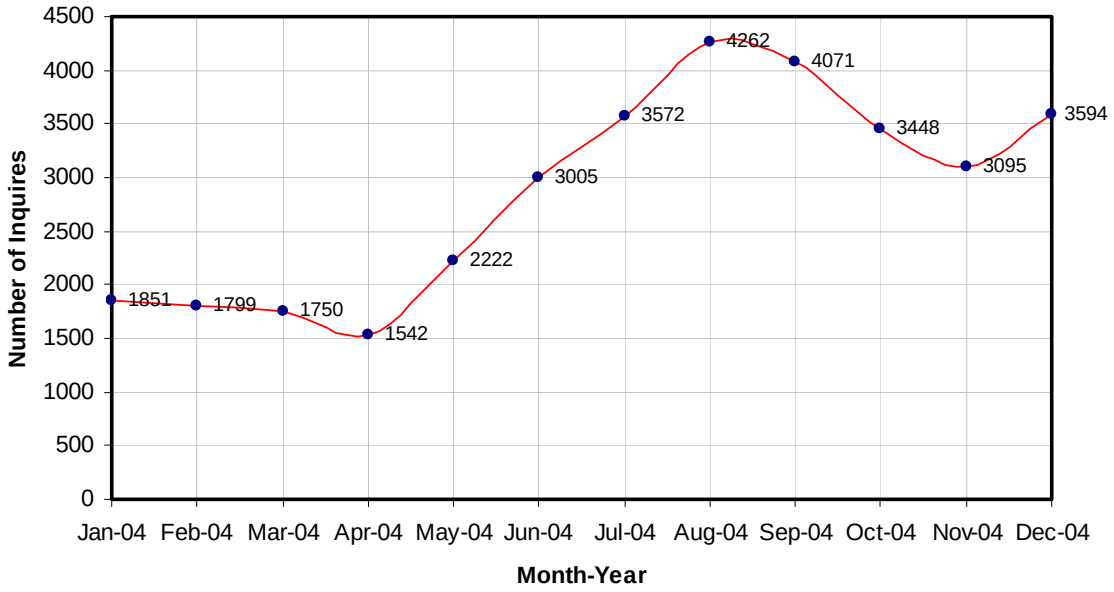


Figure 2. Number of individual PFDS data inquires per month.

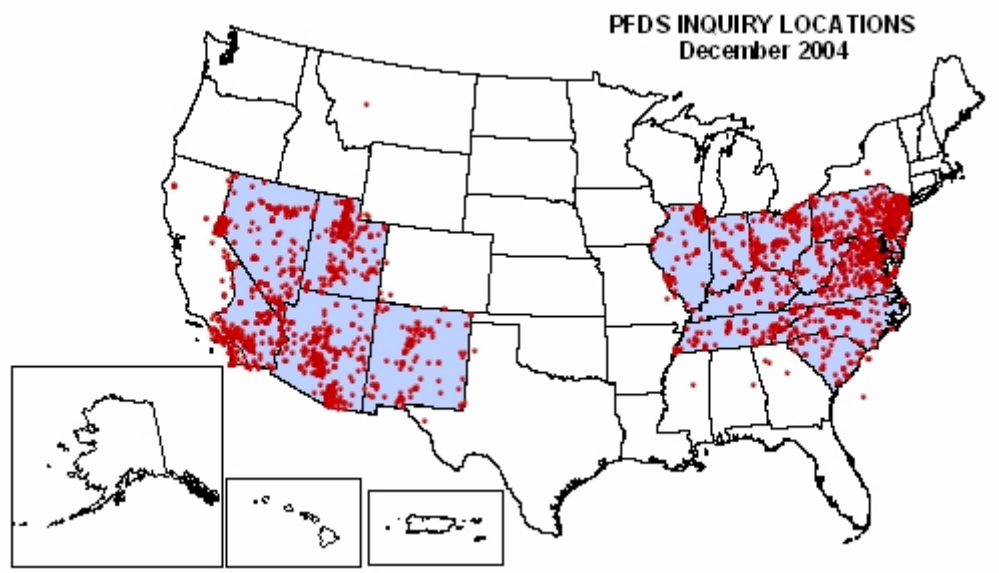


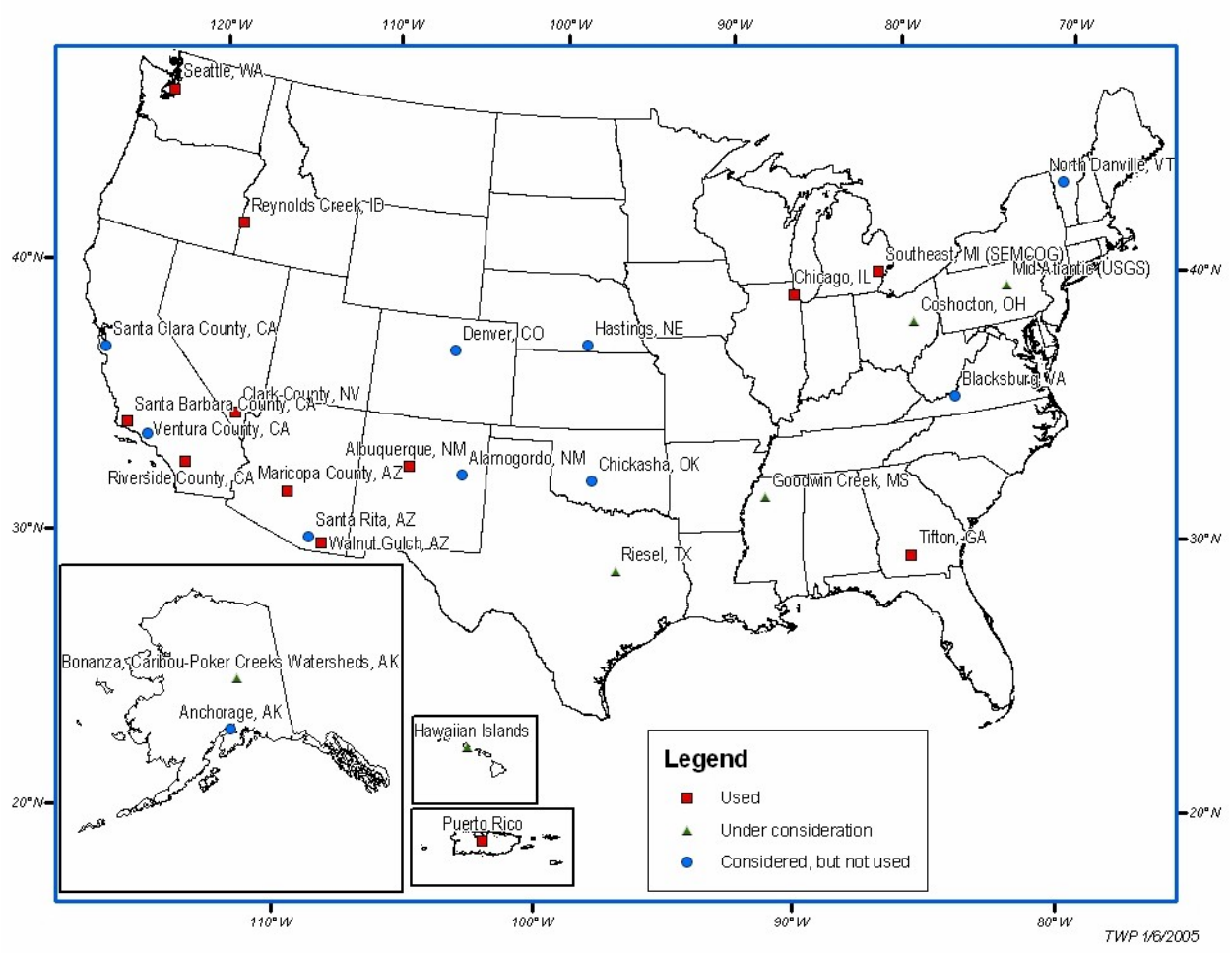
Figure 3: Map of 10,137 PFDS data inquiry locations during the period October-December 2004.

3.4 Areal Reduction Factors

Progress continues in the development of geographically-fixed Areal Reduction Factor (ARF) curves for basin area sizes of 10 to 400 square miles. Development and testing of software from the procedure described in NOAA Technical Report NWS 24 continues and is 95% completed.

Quality control of the recently added study area, Santa Barbara County, CA has been completed. The Chickasha, OK study area has been put on hold pending permission from the Oklohoma Mesonet for use of the data. The Ventura County, CA study area was eliminated due to unsuitable data records. Currently, there are 14 sites located throughout the conterminous US, Hawaii, and Puerto Rico that have been quality controlled, processed and ready for ARF analysis (see Figure 4). The “not used” study areas indicated in Figure 4 were considered but judged inadequate for the study due to lack of station density, poor data, limited or no metadata, or other problems.

Figure 4: Map of ARF study areas



4. Issues

4.1 International Cooperation

Members of HDSC were invited to the Nanjing Hydraulic Research Institute (NHRI) in Nanjing, China to demonstrate the techniques used on this project. Geoff Bonnin, Bingzhang Lin and Debbie Todd presented a seminar on December 9-10th, 2004. The seminar focused on the theory and practical application of regional precipitation frequency analysis using L-moments as used in HDSC. Members of various agencies of the Chinese Ministry of Water Resources (MWR) and various other agencies and Universities attended. These agencies included the NHRI Department of Hydrology and Water Resources, UNESCO-IHP Intergovernmental Council Bureau and Institute for Water Education, MWR Bureau of Hydrology and Office for National Flood Controlling and Commanding System, Reconnaissance, Planning, Design and Research Institute of Yellow River Conservancy Commission, Hohai University, and Tongji University. The scientific exchange was well received and generated interest in future collaboration.

The series of presentations included:

- *Recent Updates to U.S. Rainfall Frequency Estimates: Overview* by Geoff Bonnin
- *Seminar on Regional L-moments Analysis Method* by Bingzhang Lin
- *Implementation of Regional Precipitation Frequency Analysis using L-Moments* by Debbie Todd
- *Recent Updates to U.S. Rainfall Frequency Estimates: Spatial Analysis* by Geoff Bonnin
- *Recent Updates to U.S. Rainfall Frequency Estimates: Program Management* by Geoff Bonnin

5. Projected Schedule and Remaining Tasks

The following list provides a tentative schedule with completion dates. Brief descriptions of tasks to be worked on are also included in this section.

Data Collection and Quality Control [January 2005]
Trend Analysis [February 2005]
Temporal Distributions of Extreme Rainfall [February 2005]
L-Moment Analysis/Frequency Distribution [March 2005]
Peer Review of Spatially Interpolated Point Estimates [April 2005]
Spatial Interpolation of Grids [May 2005]
Precipitation Frequency Maps [June 2005]
Web Publication [May 2005]
Spatial Relations (Areal Reduction Factors) [May 2005]

5.1 Data Collection and Quality Control

During the next quarter, quality control of the updated 15-minute datasets will be completed. Stations will be checked for gaps in the data.

5.2 L-Moment Analysis/Frequency Distribution

A comprehensive L-moment statistical analysis will begin on the 24-hour and 60-minute durations and regions will be reassessed.

5.3 Trend Analysis and Temporal Distributions

Once the data have been quality controlled, an analysis for trends in the annual maximum time series and an analysis of the hourly temporal distributions of heavy rainfall can begin.

5.4 Areal Reduction Factors (ARF)

Computations for the ARF curves will be completed in the next quarter for 14 areas. The resulting curves will be tested for differences to determine if a single set of ARF curves is applicable to the entire U.S. or whether curves vary by region.

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